Technical Training Center
Facilities Tour
July 2010
Pressurized water reactors (PWR) are by far the most common worldwide, at about 66% of all operating reactors, followed by boiling water reactors (BWR). Heavy water reactors (Candu) and gas-cooled reactors (AGR) account for 6% of the total. The Soviet-era RBMK reactors represent 4% of the total.
Nuclear Plants Across US

Original Equipment Manufacturers

- B&W 7
- W 48
- CE 14
- GE 34

Map of nuclear plants across the US with highlights in different states.
Commercial Nuclear Power Plants
Reactor Power Plant Layout
Nuclear Plant Overview
Heat Produces Steam, Generating Electricity

Heat produces steam, which drives a turbine to generate electricity.
Two Types of Reactors

- **PWR – Pressurized Water Reactor**
  - Water kept under pressure in reactor – doesn’t boil
  - Water directed through steam generator
  - Steam directed from steam generator to turbines

- **BWR – Boiling Water Reactor**
  - Water allowed to boil in reactor and turn to steam
  - Steam directed from reactor to turbines

In both types of nuclear power plants, after the high-pressure steam is used to turn the turbine, it is condensed back into water and used again in the reactor.
PWR – Pressurized Water Reactor

1. Reactor Vessel
2. Steam Generator
3. Coolant Pump
4. Pressurizer
5. Generator
6. Moisture Separator and Reheater
7. Condenser
8. Condensate Pump
Typical Configurations
BWR – Boiling Water Reactor
Fuel fabrication

UF6 → Chemical reduction → UO2

Conversion into pellets

Loading pellets into fuel rods

Bundling rods into fuel assembly
Fuel Pellets
Uranium Is Encased in Solid Ceramic Pellets after Enrichment
One pound of nuclear fuel would produce enough power for the residential sector in a city the size of Detroit, Mich., for a week.

It would take 6 tons of coal or 1,200 gallons of oil or 91,800 cubic feet of natural gas to generate the same amount of electricity.
The reactor vessel is loaded with fuel for up to two years. This fuel produces the equivalent power of 8 billion pounds of coal.
Typical Fuel Assembly Elements

- Spacer Grids
- Nuclear Fuel Pellet
- Cladding
- Fuel Rod
- Guide Tube
- Instrument Tube
Fuel Assemblies

Fuel Rods
- Steel tubes, contain Pellets of Uranium 235

Control Rods
- Slow splitting of atoms
- Driven up/down by electric motors
- Emergency, rods drop by gravity
Fuel Assemblies are Inserted in Reactor Vessel
Fuel Movement - Manipulator Crane
Fuel Movement - Spent Fuel
PWR Reactor Vessel

- 41 feet tall
- 14 feet ID
- 665 tons
- 8.5 in thick walls - carbon steel with stainless steel cladding
- Holds the fuel assemblies
- Contains the nuclear reaction and heat
Typical PWR Reactor Pressure Vessel

<table>
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<tr>
<th>Description</th>
<th>Technical Data</th>
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<tr>
<td>Life time</td>
<td>60 years</td>
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<td>Coolant pressure at reactor pressure vessel outlet during power operation</td>
<td>2250 psia</td>
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<td>Coolant temperature at reactor pressure vessel inlet at full load</td>
<td>563 F</td>
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<td>Coolant temperature at reactor pressure vessel outlet at full load</td>
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<tr>
<td>Design pressure</td>
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<td>Design temperature</td>
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Steam Generators

Hot “**primary**” reactor coolant water travels through inside of tubes.

Cooler “**secondary**” water outside the tubes is heated to produce steam.

This steam is piped to a turbine that rotates by the power of the steam.
Recirculating Steam Generator
Nuclear Plant Overview

Inside Containment - Refuelling

1. Refueling Machine
2. Upender Assembly
3. Transfer Tube
4. Upender Assembly - Spent Fuel
5. Spent Fuel Handling Machine
Virginia Electricity by Energy Source

- Coal = largest fuel in Va., but pollutes the most
- Between hydro and nuclear, 34.6% uses non polluting fuel
- Costs of oil and natural gas at all time highs, and will probably stay high
- Because Virginia has a diversified mix of fuels, the state avoids some of the big swings in prices affecting other states.

Virginia Environmentally Better and More Stable Than Other States – Thanks to Hydro and Nuclear Power
Electricity Overview in Virginia

- 4 nuclear power plants and 9 coal-fired plants supply majority of base load power in Va.
- Potential Problem: transmission capacity for 3-4,000 MW into a region with peak demand of 15,000 MW
- Va. is a net importer of oil, gas and electricity

Diversity of Fuel Sources Helps Keep Virginia’s Cost of Electricity Low